ATF2 Tuning Updates

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Overview

- Clarification of studies to understand June 2012 data
  - Simulated response of SK1FF with June fitted optics parameters + dispersion source
  - Beta matching tolerances
  - All beam tracking with Lucretia
- V.5 ATF2 optics
- QF1FF replacement update

June 2012 Beam Conditions

- Optics 10x1 (rematched from 2.5x1)
  - Include all measured multipole components in quads, bends, kickers and sextupole magnets
- OTR measured beam parameters (parameters fitted back to IEX match point):
  - Emit_x = 3.8 nm
  - Beta_x = 14.5 m
  - Alpha_x = 1.2
  - Emit_y = 25 pm
  - Beta_y / Alpha_y set as nominal

IP Beam Size Descriptions

- RMS beam size, quoted as 5 numbers:
  - (1) RMS projection at IP
  - (2) RMS projection with [3,6] correlation (dispersion) removed
  - (3) RMS projection with [3,6] and [2,3] (<x'y> coupling term) correlations removed
  - (4) RMS projection with all first-order correlations removed
  - (5) RMS projection with all first and second-order correlations removed
- FIT beam size
  - Fit a gaussian profile to the core of the beam projection at IP, quoting width of gaussian

Vertical Dispersion Sources

@ QM16FF:
η_y = 33.92 mm
η_y' = -20.61 mrad

@ IP:
η_y = 1.0 mm
η_y' = 0.0 mrad
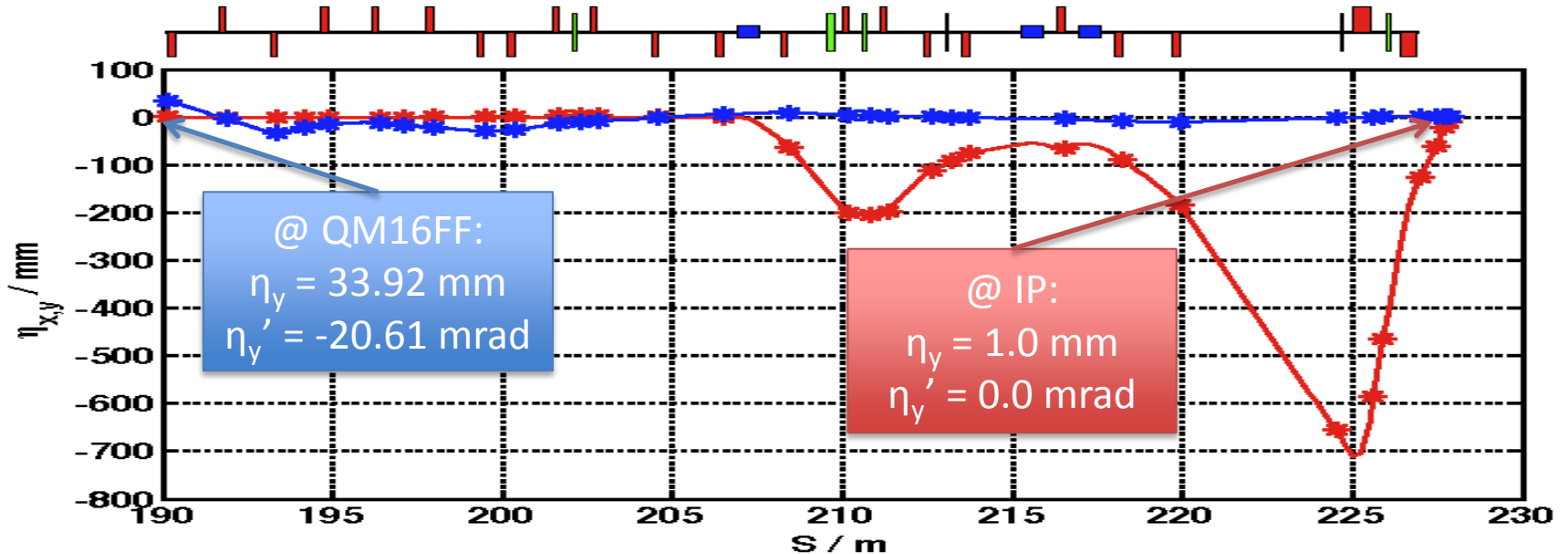
- Track beam from entrance of FFS (QM16FF)
- Generate +1mm of vertical dispersion at IP in one of 2 ways:
  - Generate initial beam with shown dispersive correlations at QM16FF
  - Offset QD0FF magnet vertically by -740 um
- Correct using sextupole-based vertical dispersion multiknob in use during June operations

Beam Tracking (no Correction)

Condition	RMS Vertical Beam Size at IP / nm				
	(1)	(2)	(3)	(4)	(5)
Design emittance and Twiss	45	45	45	45	37
June emittance and Twiss / no multipoles	105	105	105	105	54
June emittance and Twiss	104	104	104	104	54
QD0FF vertical offset / no multipoles	815	102	102	102	54
QD0FF vertical offset	828	105	105	105	54
Incoming dispersion / no multiples	808	102	102	102	54
Incoming dispersion	807	105	105	105	54

Beam Tracking (Correction with Dispersion Multiknob):

Condition	RMS Vertical Beam Size at IP / nm				
	(1)	(2)	(3)	(4)	(5)
QD0FF vertical offset / no multipoles	152	152	104	104	54
QD0FF vertical offset	139	139	112	112	54
Incoming dispersion / no multiples	151	151	106	106	54
Incoming dispersion	148	148	113	113	54

Correction with Dispersion AND Coupling Multiknobs:

| Condition	RMS Vertical Beam Size at IP / nm				
	(1)	(2)	(3)	(4)	(5)
QD0FF vertical offset / no multipoles	104	104	104	104	54
QD0FF vertical offset	112	112	112	112	54
Incoming dispersion / no multiples	106	106	106	106	54
Incoming dispersion	113	113	113	113	54

Multiknob Responses
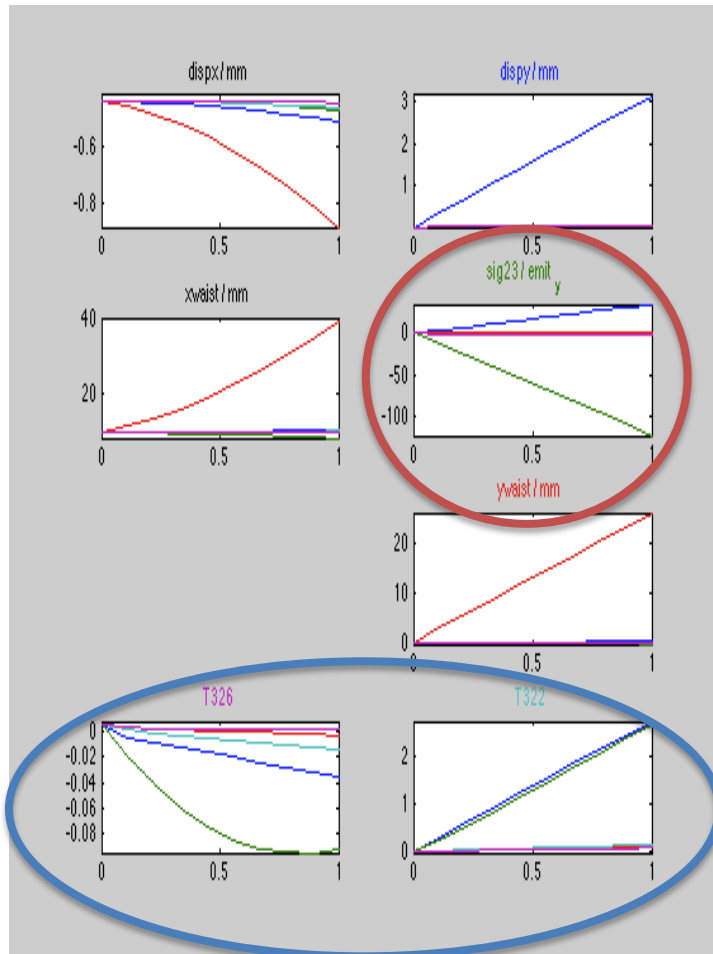
- Non-orthogonality with coupling correction
  - Dispersion correction generates coupling
- Also small amount of second-order beam size contribution (~5 nm RMS) from T322 and T326 terms when multipoles present
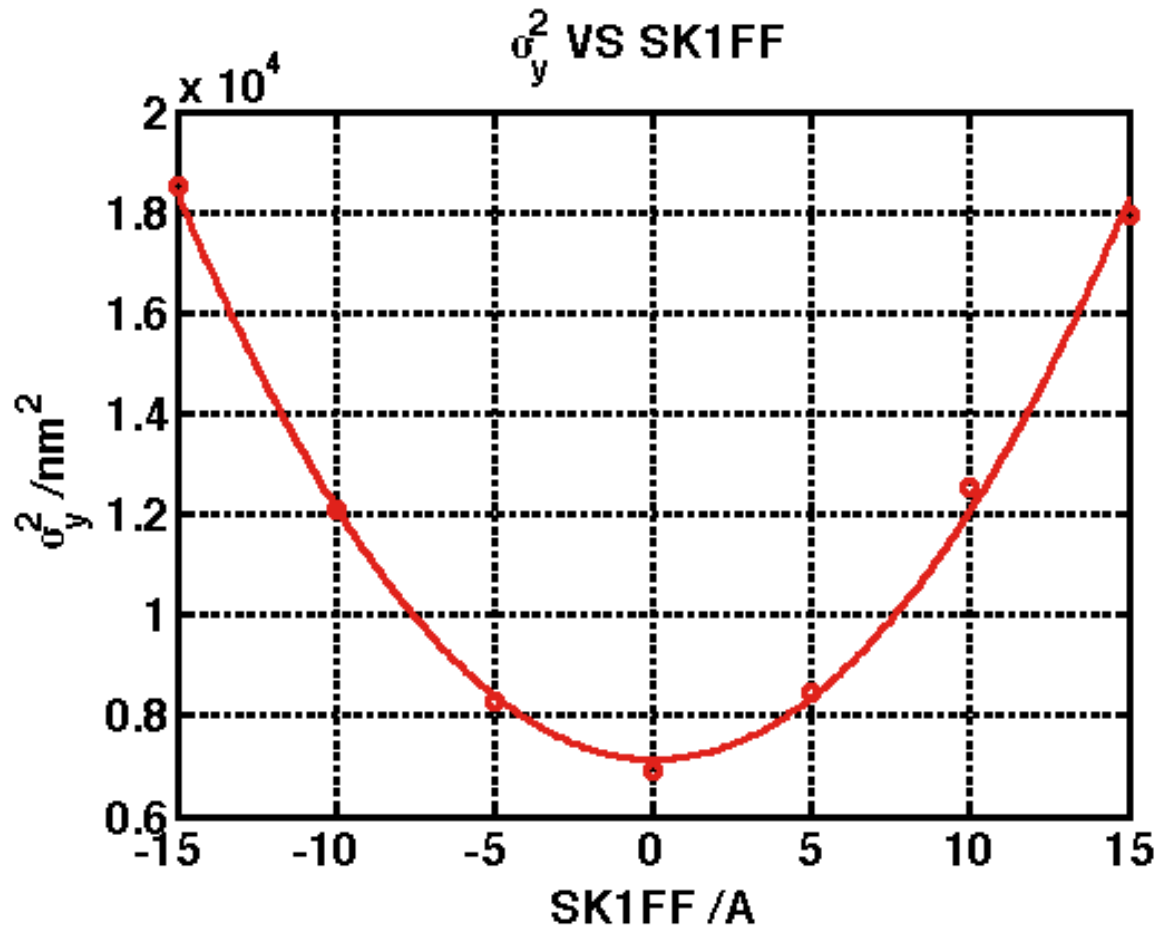
SK1FF Scan After Dispersion Correction
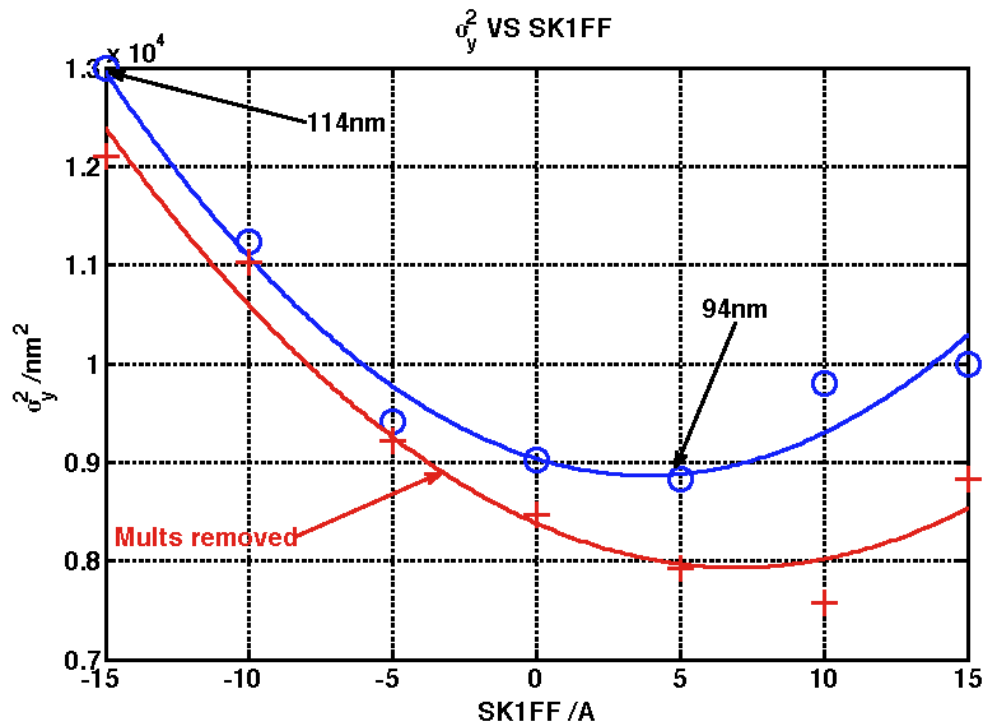
FIT beam sizes shown

- SK1FF corrects for residual coupling
- Asymmetric beam size distribution as observed in June
- Minimum of fit dependent upon residual coupling as well as any additional skew-sextupole terms

SK1FF Scan With Dispersion And Coupling Correction

σ_y^2 VS SK1FF

- No asymmetry seen with expected multipole components and corrected dispersion and coupling for each scan point
- Second-order contribution is insignificant
  - (as opposed to that theorised in previous presentation)

RMS beam sizes shown

# Vertical Beam Size Tolerance to Horizontal Beta Match
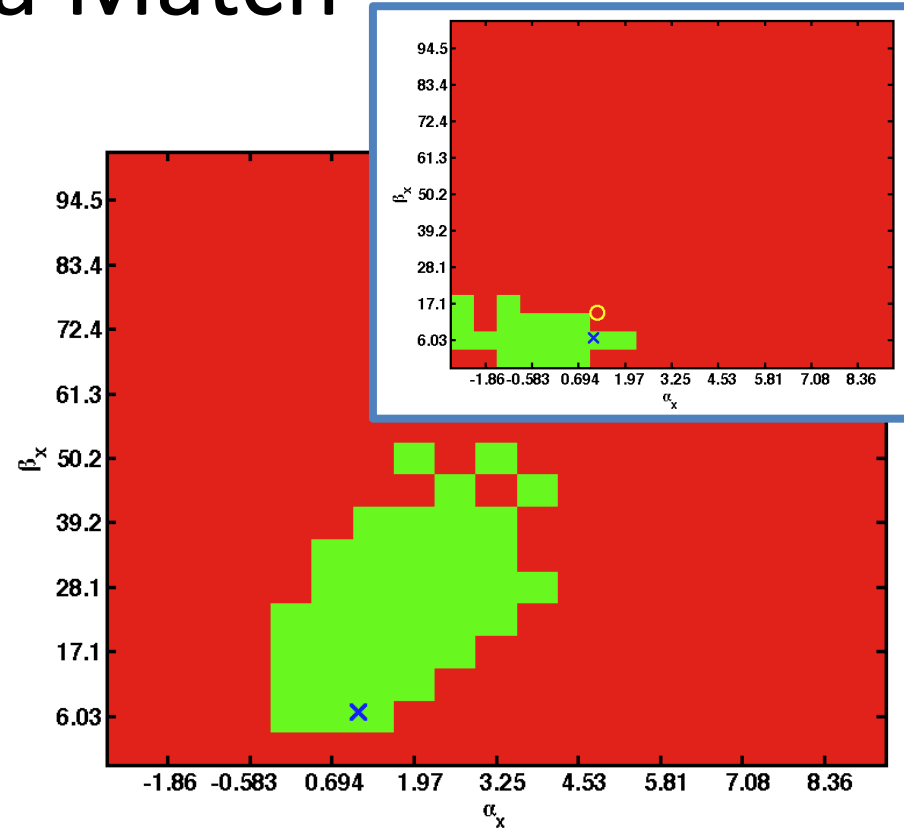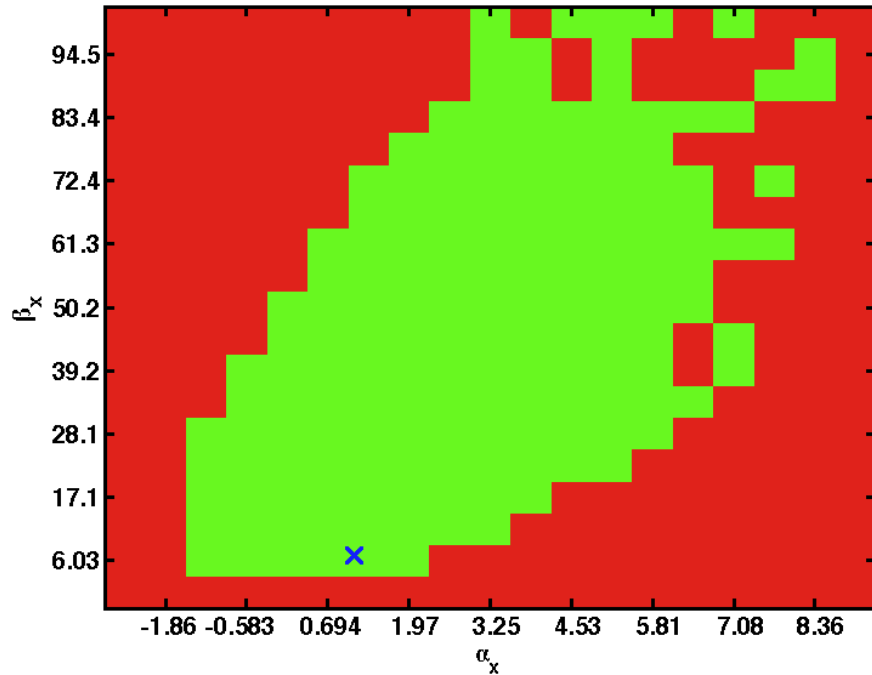
- v4.5 BX10BY1 lattice
- 2nm horizontal emittance (left)
- June (3.8 nm) horizontal emittance (right)
  - Inset = June lattice + Y emit (circle = measured twiss parameters)
- Green = vertical (RMS (4)) beam size <39 nm (after first-order corrections)
  - [Inset = < 90nm]

V.5.0 Optics Available

- Available on Flight Simulator subversion repository lattice directory
  - http://code.google.com/p/atf2flightsim/source/browse/#svn%2Ftrunk%2FATF2%2FFlightSim%2FlatticeFiles%2Fsrc%2Fv5.0
  - XSIF and Lucretia file formats
    - .saveline and .mat extensions
- BX10BY1 lattice
  - All multipoles as in v.4.5 for now (QF1FF replacement still pending)
  - Removed KEX2 quad and sextupole field (KEX2 removed)
- New components
  - 3 new skew-sextupoles (v4.5 SK1FF -> SK3FF)
    - SK1FF, SK2FF, SK3FF, SK4FF
  - IP feedback kicker

V 5.0 Optics Matching and Tracking
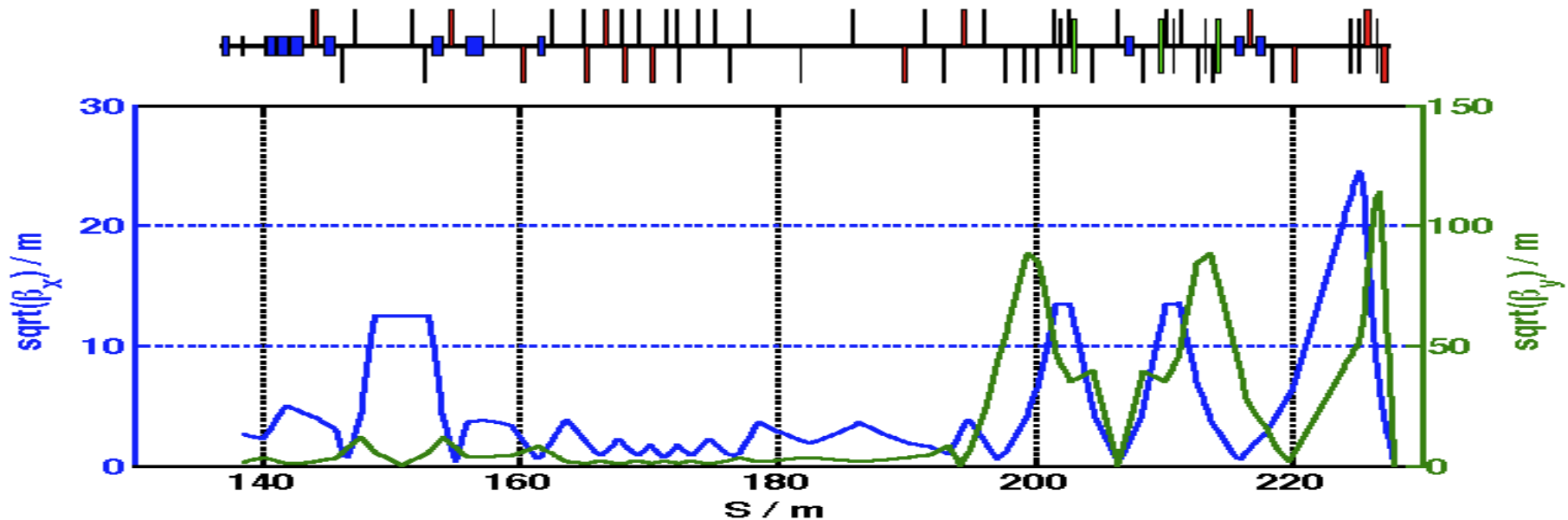
- Matched with waists at MFB1FF (horizontal) and MFB2FF (vertical) in MAD using QD21X, QM(16:12)FF.
  - QF21X was found to be necessary to keep FB waists
- Tracked IP beam sizes (Lucretia)
  - 10 um x 35 nm (no multipoles)
  - 10 um x 40 nm (all multipoles)

Rematch Sextupoles with Lucretia

- Try re-matching sextupole strength to minimise IP beam size in presence of multipoles
- Can get design (37 nm) IP vertical beam size with below values
  - Same with multipoles switched off
  - ***NB: force SF5FF not to reduce in value to maintain tuning capability of sextupole system***

```
SIGMA_Y=37nm:
SD0FF: Lucretia: +21.66974284 (T.m) K2: +49.97250747 K2L: +04.99725075 I:  7.37255944 (A)
SF1FF: Lucretia: -14.76999747 (T.m) K2: -34.06103223 K2L: -03.40610322 I:  5.01071205 (A)
SD4FF: Lucretia: +61.98265762 (T.m) K2: +142.82650898 K2L: +14.29379594 I: 27.24028031 (A)
SF5FF: Lucretia: -03.42946817 (T.m) K2: -07.90251636 K2L: -00.79086829 I:  1.07188021 (A)
SF6FF: Lucretia: +24.84119592 (T.m) K2: +57.24151606 K2L: +05.72861828 I: 10.72236363 (A)
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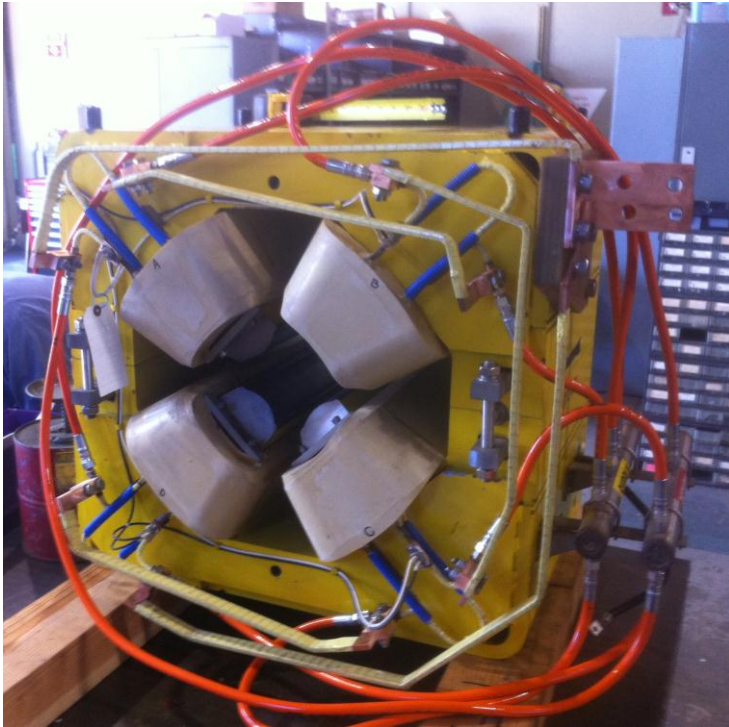
QF1FF Replacement Update

- PEPII LER quad refurbished for our use
- Currently undergoing multipole measurements + BPM feed-through tests
- Hopefully ship next week? (if paperwork time allows)
- Weight confirmed at 1188.4 kg